ColorSync Update

Session 206

ColorSync Update

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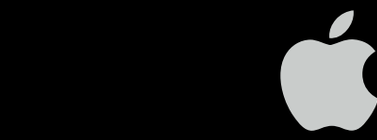
ColorSync Engineering

Introduction

- Overview of ColorSync
- Device Integration
- ColorSync and Quartz
- ColorSync Utility
- ColorSync and OpenGL
- Display Calibration
- SIPS
- Q&A

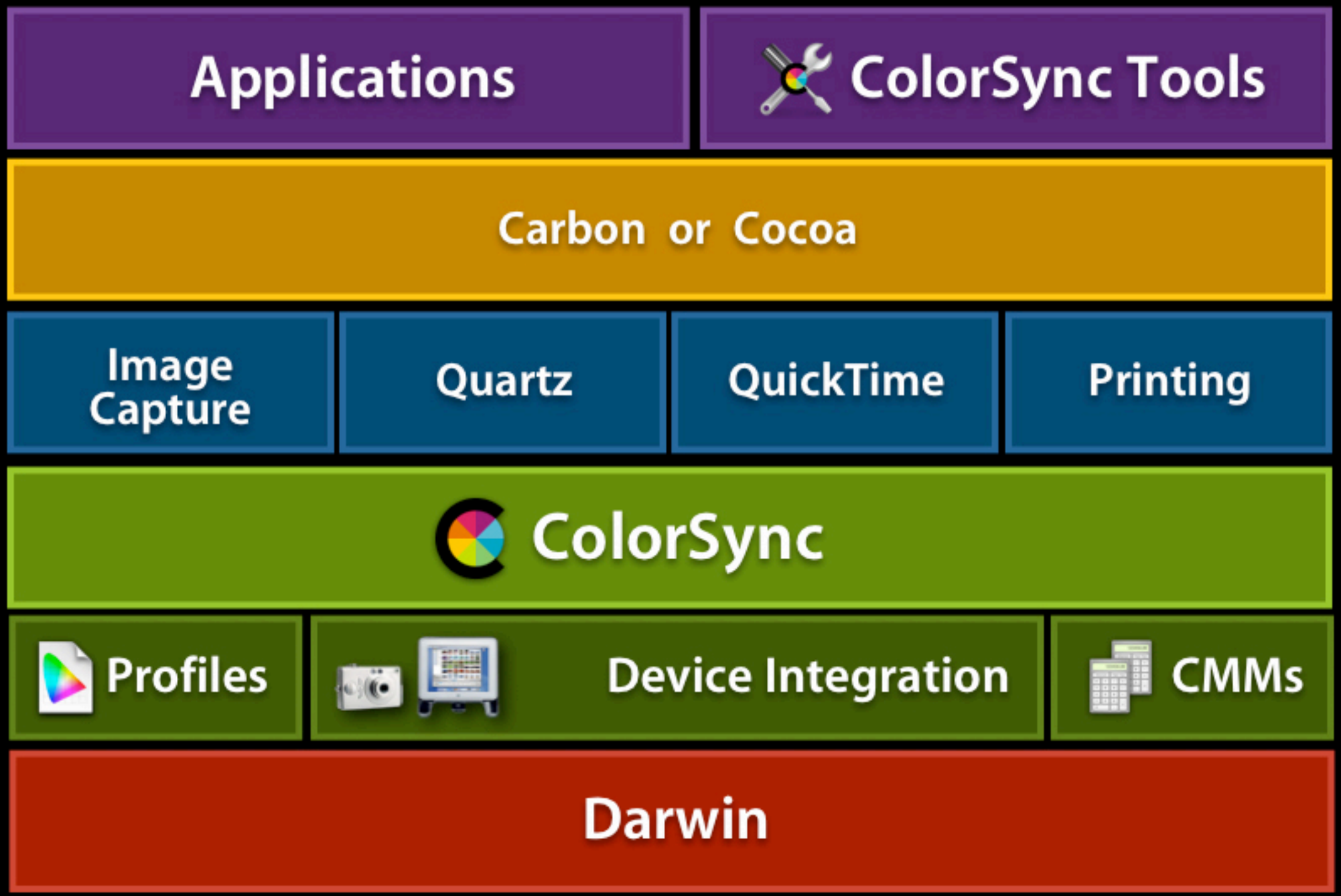


Overview of ColorSync

Overview of ColorSync

- Problem:
  - Devices represent color in different spaces with different gamuts
- Solution:
  - ColorSync is a complete color management system, designed to provide consistent color across devices
  - ColorSync can also be used to produce special color effects

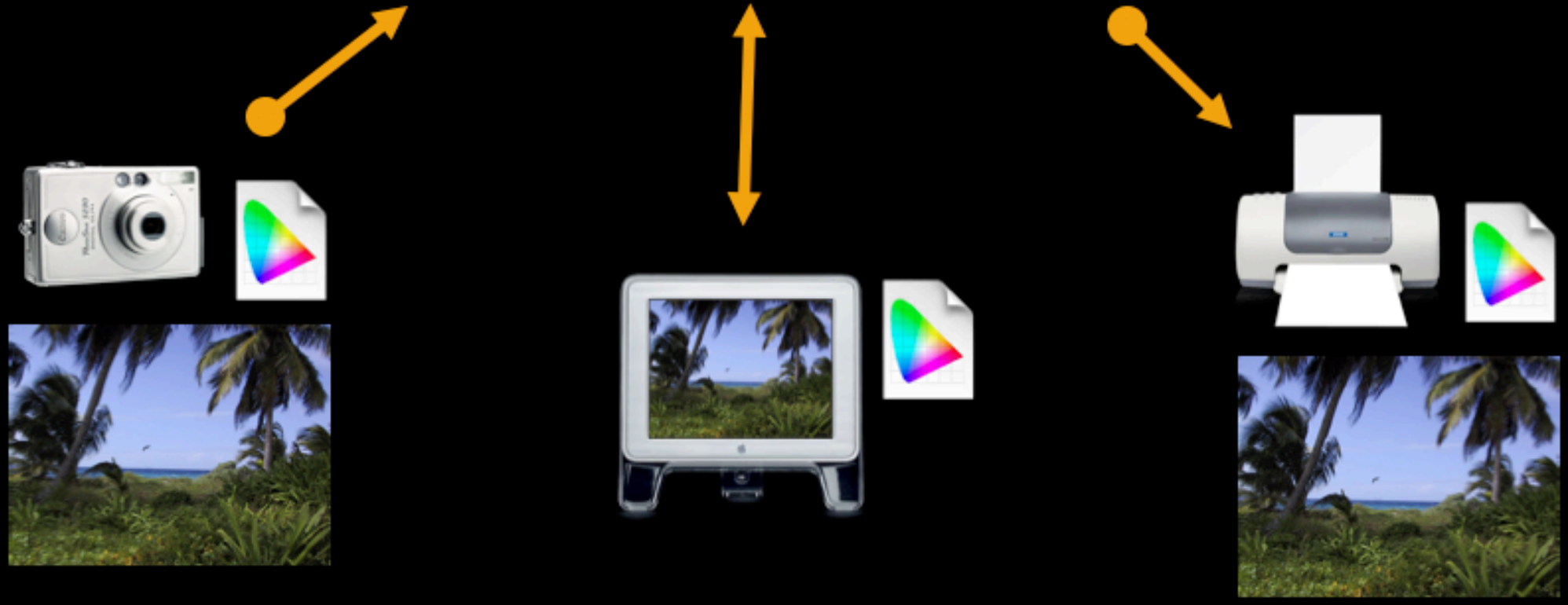
Overview of ColorSync



Overview of ColorSync

An Application

ColorSync



A ColorSync Chain

- Acquired by Image Capture Arch
- Edited in a Carbon App
- Converted by a QuickTime tool
- Printed from Preview
  - Rasterized by Quartz
  - Through a printer driver
  - To an ink-jet printer

A ColorSync Chain—Weak Links

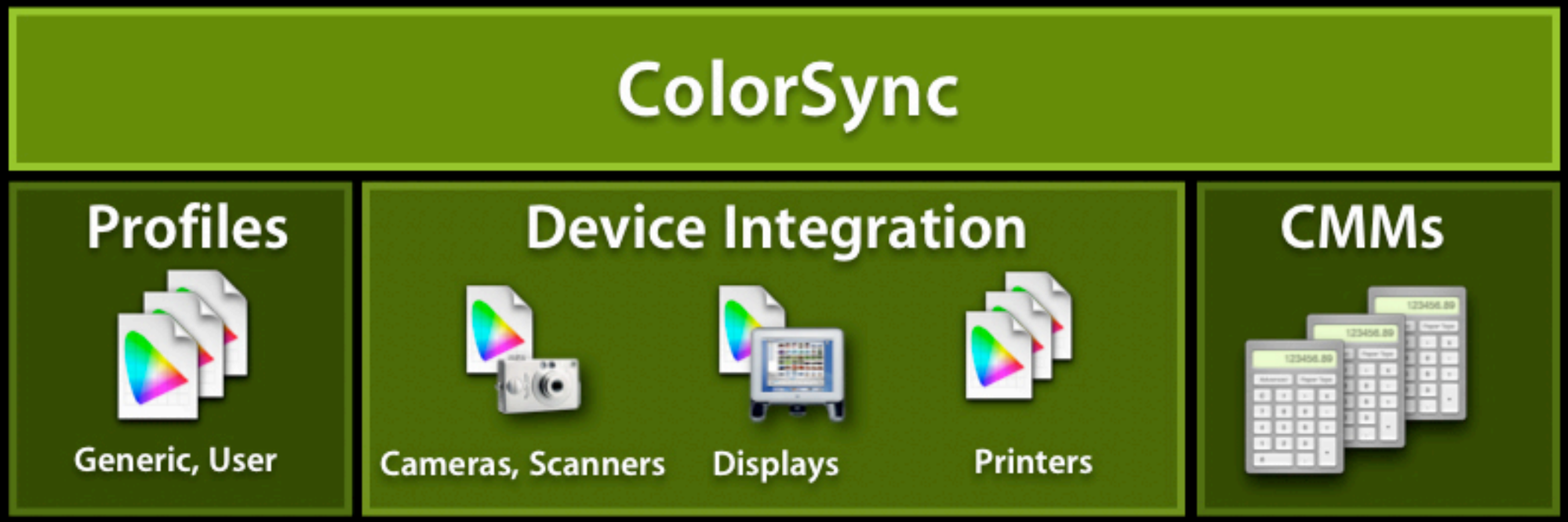
- Acquired by Image Capture Arch
  - Few cameras register profiles
- Edited in a Carbon App
- Converted by a QuickTime tool
  - Apps must check for embedded profiles
- Printed from Preview
  - Rasterized by Quartz
  - Converted to a printer's color space
    - Some printers don't register profiles
  - Sent by driver to an ink-jet printer

A ColorSync Chain—Fixed Links

- Acquired by Image Capture Arch
  - Generic Camera Profile registered by default
- Edited in a Carbon App
- Converted by a QuickTime tool
  - Apps no longer need to check for embedded profiles
- Printed from Preview
  - Rasterized by Quartz
  - Converted to a printer's color space
    - PostScript and CUPS drivers can now register profiles
  - Sent by driver to an ink-jet printer

ColorSync Device Integration

ColorSync Device Integration



ColorSync Device Integration

- Allows for automatic registration of:
  - Device ID and Name
  - Device Mode IDs and Names
  - Factory Profiles
- Supports override profiles
  - Calibration applications will override
  - Administrator can override factory profiles
  - Users can override factory and admin profiles
- API for applications to query current profile of devices

Device and Profile Registration

Automatic registration by Device Managers

- Window Server: when a display is detected
- Image Capture: when the camera is plugged in
- Print Manager: when a print queue is created
  - Tioga printers:
    drivers provide list of print modes and associated profiles
  - CUPS printers: (PostScript and raster)
    print mode and profiles declared in PPDs

Device and Profile Registration

New PPD Declaration Entry

- *cupsICCProfile {mode specifier} {profile specifier}
  - Mode specifier:
    - Three fields combined in form:
      ColorModel.MediaType.Resolution
    - Fields can be empty to signify any model/media/resolution
  - Profile specifier:
    - File path relative to /usr/share/cups/profiles/

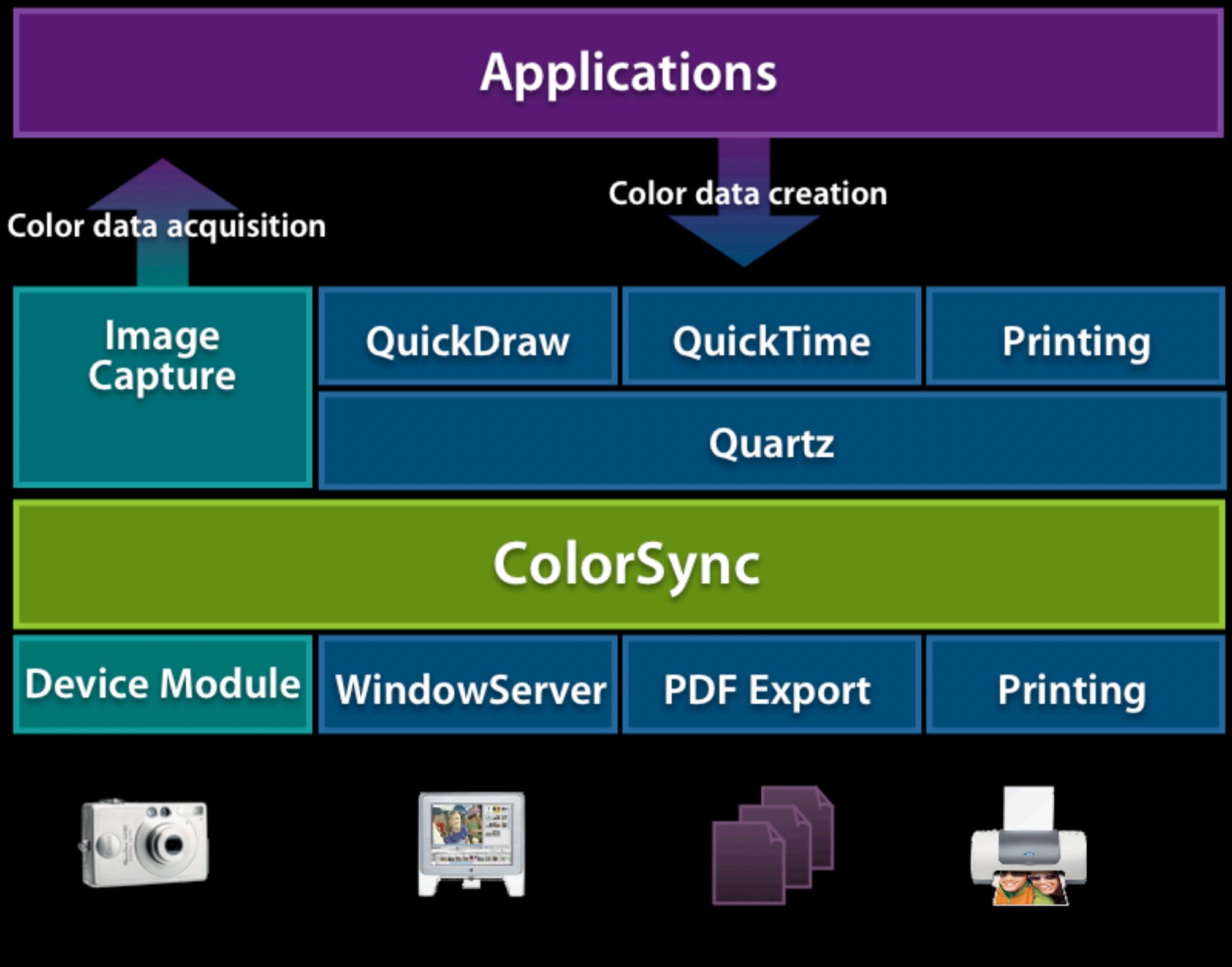
ICC Profiles In PPD—Example

```
*%============================
*% Device capabilities
*%============================

*ColorDevice: True

*DefaultColorSpace: CMYK

*cupsICCProfile   ..600x600dpi     “cmykProfile600dpi.icc”
*cupsICCProfile   ..1200x1200dpi “cmykProfile1200dpi.icc”
```

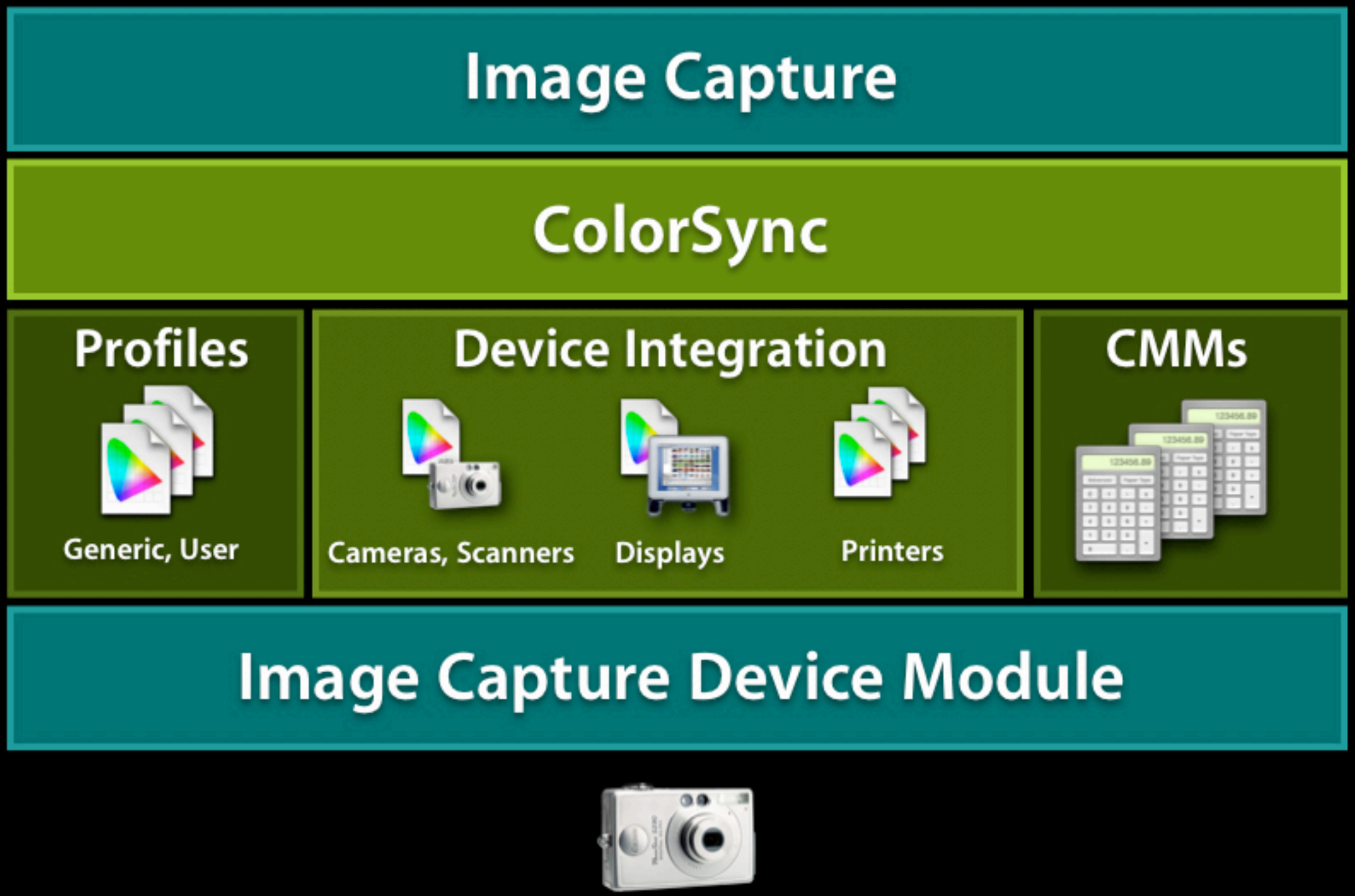
Demo

Device Registration

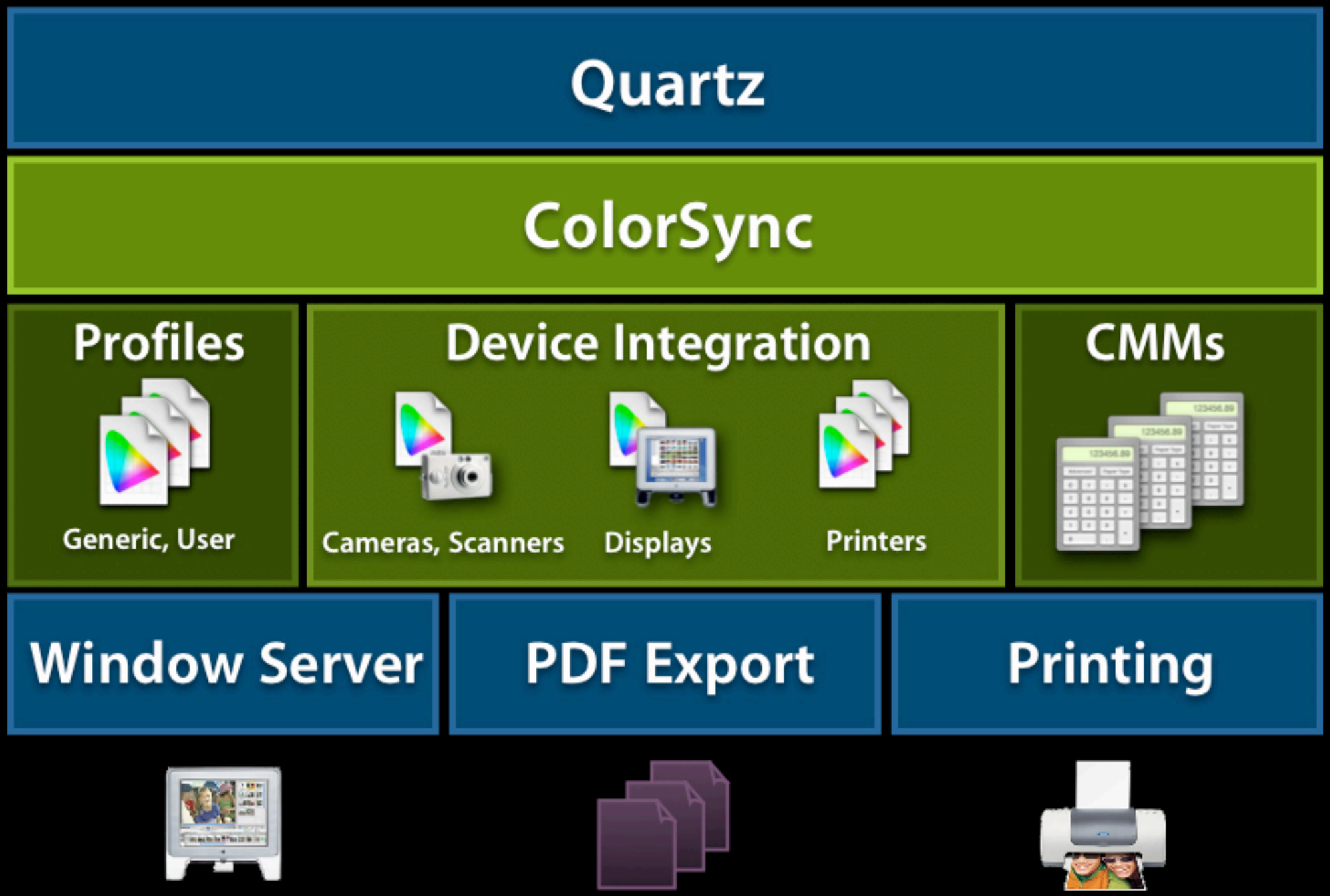
Mac OS X Color Processing Stack



Color Data Acquisition



Color Data Creation



ColorSync and Quartz

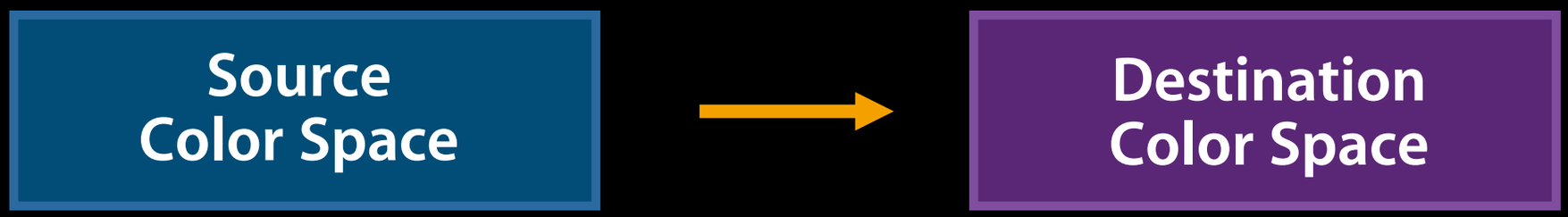
Color Management in Quartz

- Objective
  - Integrated graphics and color management

- Requirements
  - Centralized color matching for consistent results
  - Composite different color spaces and opacity
  - Scalable solution
  - Color accuracy
  - Performance
  - PDF compatibility

Note on PDF Compatibility

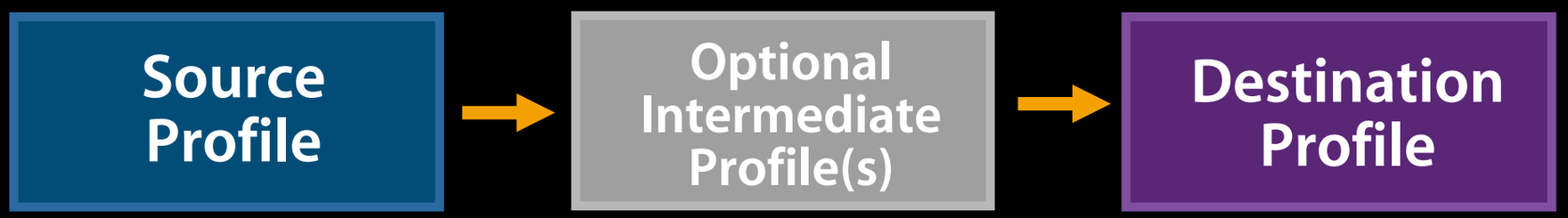
- PDF color definition
  - /DeviceGray, /DeviceRGB, /DeviceCMYK
  - /CalGray, /CalRGB, /CalLab
  - /ICCBased
- PDF color conversions
  - Source, destination and rendering intent



Rendering intent = {perceptual, relative colorimetric, saturation, absolute colorimetric}

Note on ColorSync/ICC Color Model

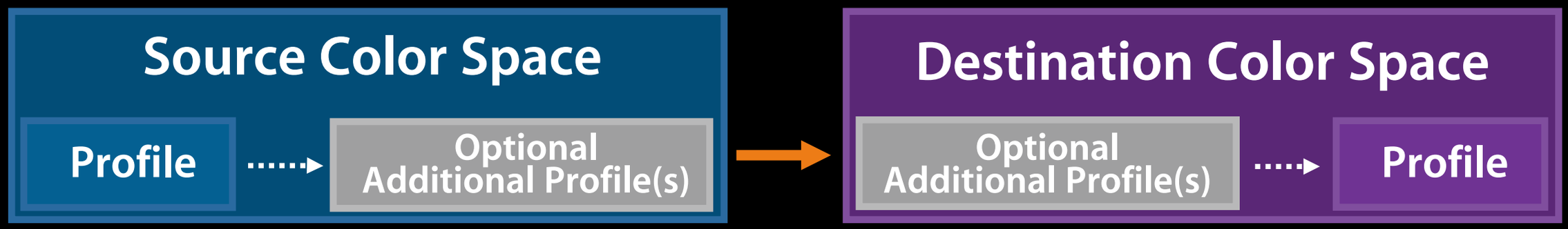
- ICC color definition
  - ICC Profile
- ICC color conversions
  - Two or more profiles and rendering intents



Rendering intent = {perceptual, relative colorimetric, saturation, absolute colorimetric}

Color Space Model In Quartz

- Color space is one or more ICC profiles

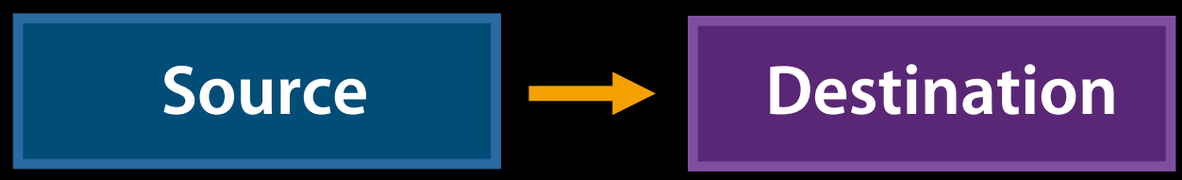


  - Preserve PDF concept of matching source to destination
  - Suitable for advanced color management like softproofing, special effects, color device simulation, etc.
  - Can be concatenated by ColorSync to a single ICC profile

Color Inside Quartz

Color space equivalence

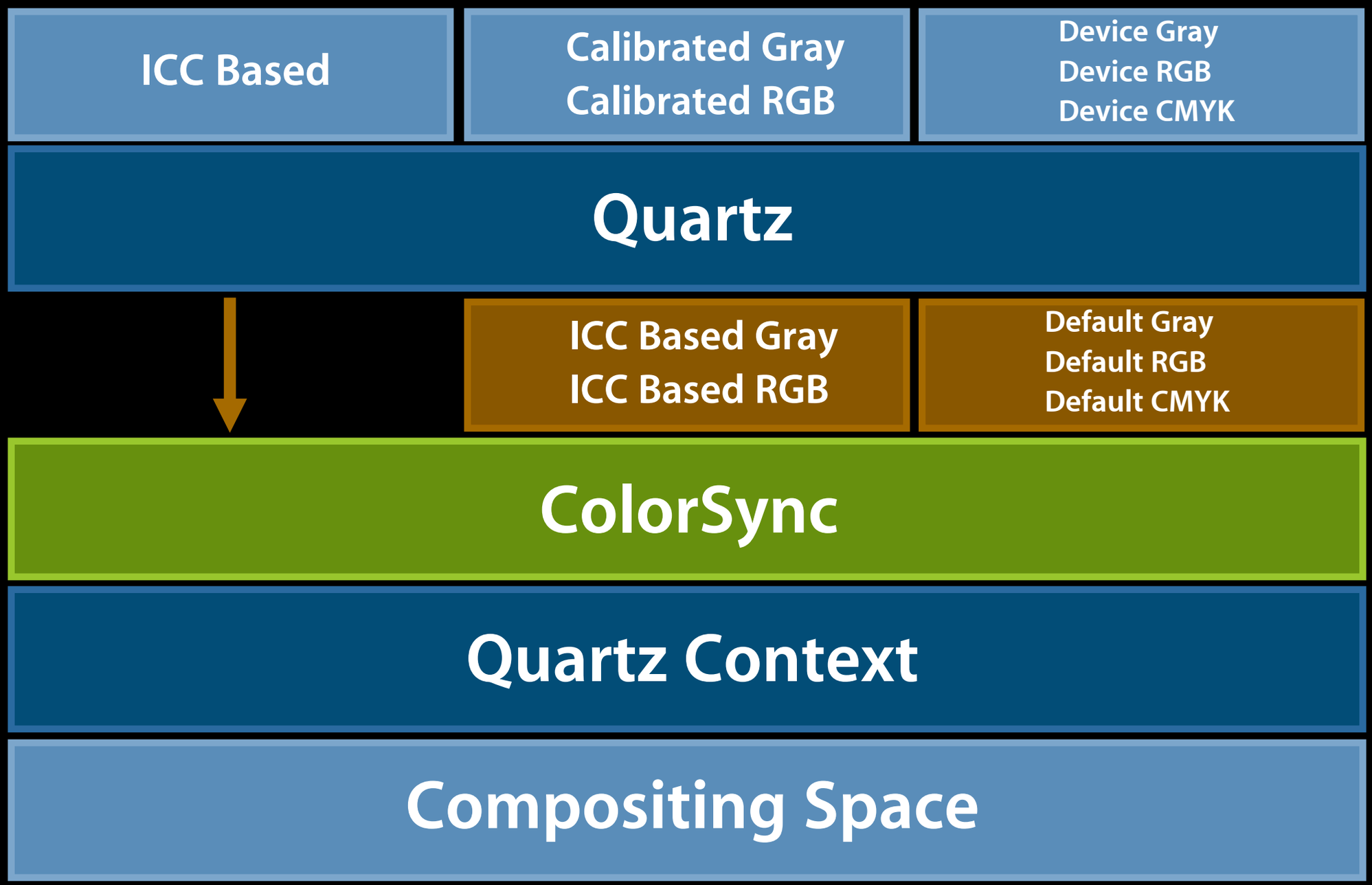
```
if (source color space == destination color space)
{    // no conversion needed - data remains unaltered
```




```
}
else
{    // conversion needed - call ColorSync
```

```
}
```

Color Inside Quartz



Drawing to the Screen

Special color spaces for drawing to the screen

Display RGB = Primary Display Profile

Display Gray = Gray to RGB → Primary Display Profile

Display with ID = Display By AVID Profile

Drawing to Multiple Screens

Application's choice:

- Simple model
  - Color matched only to the main display
  - No updates on screen/profile change
- Complete model
  - Color matched to individual displays
  - Updates on screen/profile change
- Some combination of the above

Color Management In Printing

Printing's two main components:

- Front-End
  - Choosing the printer and print options
  - Spooling the print job into PDF
- Back-End
  - Converting the spooled PDF
    - Raster (Tioga and CUPS raster printers)
    - PostScript

Color Management In Printing

Front-End:

- All color data in spooled PDF is tagged with profiles
- No printer specific color conversions
- Printer profiles retrieved from ColorSync Device Integration database and added to the print job

Color Management In Printing

Back-End: Raster printers

- Color data is converted to the printer profile
  - Printer profile retrieved from the print job
  - Default profile if no profile in the print job

Color Management In Printing

Back-End: PostScript printers

- Color matching in the printer
  - Profiles from spooled PDF converted to PostScript CSAs
- Color matching on the host by ColorSync
  - Printer profiles retrieved from the print job
  - Default profiles if no profiles in the print job

Drawing In Printer Color Space

Special color space for printing

- Based on the printer instance and print settings

Printer Color Space = **ColorSync Profile from Printer Settings**

Printer Calibration API

Support for printing calibration target

- Print a PDF file through the calibration path on a specified printer

Calibration Target Info =

Target - ICC Based color space
Gray Override - ICC Based color space
RGB Override - ICC Based color space
CMYK Override - ICC Based color space

Importing Untagged Data

Special color spaces for user preferred profiles

User Default Gray	=	ColorSync Default Gray profile for documents
User Default RGB	=	ColorSync Default RGB profile for documents
User Default CMYK	=	ColorSync Default CMKY profile for documents

Quartz Filters

Recipes to control Quartz rendering

- Modifies Quartz drawing operations to a context
  - Add a sequence of imaging and color correction operations to a single drawing
  - Acts on all drawing operations or on a specified set
  - Can be configured to perform specialized imaging or color operations
  - Defined and saved in XML

Quartz Filters

ICC Based

Calibrated Gray
Calibrated RGB

Device Gray
Device RGB
Device CMYK

Quartz

Quartz Filter

ColorSync

Quartz Context

Compositing Space

Demo

Filters

ColorSync Utility

ColorSync Utility

- New home for ColorSync Preferences
- Filters support
- Administration features
- Profile First Aid
- New 3D View options

Demo

ColorSync Utility

ColorSync and OpenGL

ColorSync and OpenGL

- Real-time color correction for video
- Make use of per-pixel 3D texture-map hardware available on the video card
  - nVidia GForce4TI, ATI Radeons, etc.
- Combines ColorSync, OpenGL, QuickTime, Quartz
  - Play QuickTime content
  - On a Quartz OpenGL surface
  - With a 3D texture built from a ColorSync CWorldRef

ColorSync and OpenGL

- New ColorSync API
  - To create an Abstract or RGB Profile:

    CMMakeProfile(CMProfileRef prof, CFDictionaryRef spec)
  - To fill a 3D color texture:

    CWFillLookupTable(CWWorldRef cw, UInt32 grid, UInt32 fmt, ...)

ColorSync and OpenGL

- New ColorSync API—CMMakeProfile

```
void makeAbstractWithAngle (CMProfileRef prof, float angle)
{
   CFDictionaryRef dict;
   SInt64          cb64, rc64;
   CFStringRef     keys[2];
   CFTypeRef       vals[2];

   cb64 = (SInt64) myLabToLabProc;
   key[0] = CFSTR("proc");
   vals[0]= CFNumberCreate(0, kCFNumberSInt64Type, &cb64);
```

ColorSync and OpenGL

- New ColorSync API—CMMakeProfile

```
    rc64 = (SInt64) &angle;
    key[1] = CFSTR(”refcon”);
    vals[1]= CFNumberCreate(0, kCFNumberSInt64Type, &rc64);

    dict = CFDictionaryCreate(nil, keys, vals, 2,
        &kCFTypeDictionaryKeyCallBacks,
        &kCFTypeDictionaryValueCallBacks);

    CMMakeProfile(prof, dict);

    CFRelease(vals[0]); CFRelease(vals[1]);
    CFRelease(dict);
}
```

ColorSync and OpenGL

- New ColorSync API—CMMakeProfile

```
void myLabToLabProc
   (float* L, float* a, float* b, void* refcon)
{
   float   angle = *(float*)refcon;
   float   aa = (*a), bb = (*b);
   *a = aa*cos(angle) - bb*sin(angle);
   *b = aa*sin(angle) + bb*cos(angle);
}
```

ColorSync and OpenGL

- New ColorSync API—CWFillLookupTable

```
void* make_3d_texture
   (CMProfileRef src, CMProfileRef abs, CMProfileRef dst)
{
   UInt32     size, grid = 9, fmt = cmTextureRGBtoRGBX8;
   CMWorldRef cw;
   void*      data;

   cw = make_colorworld(src, abs, dst);
   err = CWFillLookupTexture(cw, grid, fmt, &size, nil);
   data = malloc(size);
   err = CWFillLookupTexture(cw, grid, fmt, &size, &data);
   return data;
}
```

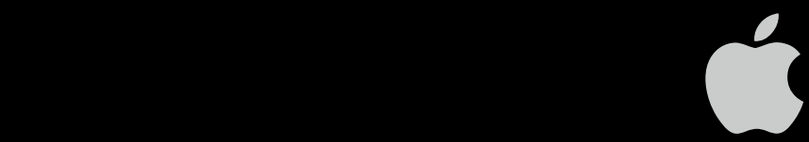
Demo

ColorSync and OpenGL

Display Calibration

Display Calibration

- Support for your calibrator
  - Build your Carbon or Cocoa calibration application
  - Add CSDisplayCalibrator key to the Info.plist
  - Support the optional property in the ‘oapp’ event
  - Install your calibrator (or a symlink to it) in /Library/ColorSync/Calibrators/
- An example calibrator
  - In /Developer/Examples/ColorSync/



Demo

Display Calibration

SIPS

SIPS

- Scriptable Image Processing System
  - Motivation
  - Features
  - Architecure
  - How to use it

SIPS

- Motivation: we need a tool to perform common operations on image files
  - ColorSync Scripting
    - Can match but not rotate, scale or convert formats
  - ImageCapture Scripting
    - Can rotate and scale but not match or convert formats
  - Preview
    - Can rotate, scale and convert formats but not Apple-scriptable

SIPS

- Features
  - Read, write or convert between raster image formats
    - JPEG (Jfif & Xiff), TIFF, GIF, PNG
  - Basic Image Operations
    - Rotate, flip, crop, pad, resample, change dpi
  - Color Management Operations
    - Embed, extract or match to profiles
  - Read or write known metadata tags
  - Preserve original content whenever possible

SIPS

- Possible future features
  - Support for complex formats
    - Multi-layer, multi-page or vector-based
  - Advanced Image Operations
    - Blur, sharpen, enhance, etc.
  - Read or write any metadata tag

SIPS

- Architecture
  - Currently implemented as a compiled tool
    - /usr/bin/sips
  - Links against CoreGraphics, QuickTime and ColorSync
  - Can operate on one or more file at a time
  - Can query or modify images or profiles
  - Queries can return properties as simple text or XML form
  - Actions can modify files in-place or to an output directory

SIPS

- How you can use it
  - From Terminal shell
  - From AppleScript
  - From other scripting languages
  - From your app using C-code

Demo

SIPS

Wrap Up

Roadmap

200 Graphics and Imaging Overview Latest developments in Mac OS X graphics APIs.	**Presidio** **Tue., 10:30am**
201 Mac OS X OpenGL in Depth Introduction to OpenGL on Mac OS X.	**Nob Hill** **Tue., 2:00pm**
202 Technology Magic of Keynote How Keynote uses Mac OS X graphics technologies.	**Nob Hill** **Tue., 3:30pm**
204 Image Capture Update Integrating Image Capture with your product.	**Marina** **Wed., 9:00am**

Roadmap

205 Vertex Programming with OpenGL Super-fast geometry transformations using the GPU.	**Marina** **Wed., 3:30pm**
206 ColorSync Update Latest developments in Mac OS X color management.	**Mission** **Wed., 5:00pm**
207 Quartz 2D in Depth Harnessing the power of Quartz 2D in your product.	**Presidio** **Thur., 9:00am**
208 Fragment Programming with OpenGL Creating incredible per-pixel effects on Mac OS X.	**Pacific Heights** **Thur., 10:30am**

Roadmap

209 OpenGL Optimizations Obtaining maximum 3D performance on Mac OS X.	**Marina** **Thur., 2:00pm**
210 Mac OS X Printing Update Latest developments in the Mac OS X printing system.	**Mission** **Thur., 3:30pm**
211 Introduction to Quartz Services Capturing & configuring displays on Mac OS X.	**Pacific Heights** **Fri., 9:00am**
212 Cutting Edge OpenGL Techniques Expert recipes for stunning 3D effects.	**Russian Hill** **Fri., 2:00pm**

Roadmap

421 Mac OS X Accessibility Latest developments in Mac OS X accessibility.	**Presidio** **Fri., 10:30am**
FF018 Graphics & Imaging Feedback Share your thoughts on graphics & imaging technologies.	**North Beach** **Fri., 5:00pm**

Who to Contact

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http://developer.apple.com/wwdc2003/urls.html

For More Information

Reference Library

Documentation

ColorSync Manager Reference

http://developer.apple.com/techpubs/macosx/Carbon/graphics/ColorSyncManager/ColorSync_Manager/colorsync_mgr_ref/index.html

What's New in Quartz 2D

http://developer.apple.com/techpubs/macosx/CoreTechnologies/graphics/Quartz2D/WhatsNewQuartz2D/index.html

Drawing With Quartz 2D

http://developer.apple.com/techpubs/macosx/CoreTechnologies/graphics/Quartz2D/drawingwithquartz2d/index.html

Reference Library

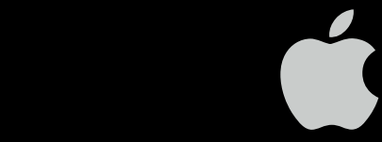
Technical Notes

TN2035: ColorSync on Mac OS X
http://developer.apple.com/technotes/tn/tn2035.html

TN2014: Insights on OpenGL
http://developer.apple.com/technotes/tn/tn2014.html

Technical Q&As

QA1145: Preserving ColorSync Profiles when using QuickTime when using Graphics Importers/Exporters
http://developer.apple.com/qa/qa2001/qa1145.html



Q&A

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http://developer.apple.com/wwdc2003/urls.html

WWDC 2003

Worldwide Developers Conference